IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s)	:	Manfred HELLMANN et al.
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For	:	METHOD AND DEVICE FOR TRIGGERING A REQUEST FOR TAKING CONTROL IN ACC-CONTROLLED VEHICLES
Examiner	:	To Be Assigned
Art Unit	:	To Be Assigned

Assistant Commissioner for Patents
Washington, D.C. 20231

PRELIMINARY AMENDMENT AND
37 C.F.R. § 1.125 SUBSTITUTE SPECIFICATION STATEMENT

SIR:

Kindly amend the above-identified application before examination, as set forth below.

IN THE SPECIFICATION AND ABSTRACT:

In accordance with 37 C.F.R. § 1.121(b)(3), a Substitute Specification (including the Abstract, but without claims) accompanies this response. It is respectfully requested that the Substitute Specification (including Abstract) be entered to replace the Specification of record.

IN THE CLAIMS:

On the first page of claims, first line, change "What is claimed is:" to --WHAT IS CLAIMED IS:--.

Please cancel, without prejudice, claims 1 to 8 in the underlying PCT application.

EV003627426US

Please add the following new claims:

--9. (New) A method for notifying a driver of a vehicle having an adaptive cruise control, comprising the steps of:

(a) signaling that at least one of a maximum braking force and pressure controllable by the adaptive cruise control is being applied and a deceleration therefrom is not sufficient to automatically decelerate the vehicle in time and to a sufficient degree; and

(b) activating a request for taking control when at least two criteria relating to deceleration values are simultaneously satisfied.

10. (New) The method according to claim 9, wherein the at least two criteria include values corresponding to vehicle deceleration, one of the values being limited in accordance with at least one of a time-related change variable, a maximum steepness variable, and an absolute value variable.

11. (New) The method according to claim 9, wherein a value of the at least one of the maximum braking force and pressure is changeable.

12. (New) The method according to claim 11, wherein the value of the at least one of the maximum braking force and pressure is changeable as a function of at least one of a speed being instantaneously driven, road conditions and loading of the vehicle.

13. (New) The method according to claim 9, wherein the at least two criteria include at least three criteria, the request for taking control being activated in the activating step (b) when the at least three criteria are simultaneously satisfied.

14. (New) The method according to claim 13, wherein the criteria include a signal indicating that the adaptive cruise control is actively controlling the vehicle.

15. (New) The method according to claim 9, further comprising the step of:

(c) activating a request for taking control when one of at least one further condition is satisfied independent of the activating step (b).

16. (New) The method according to claim 15, wherein the further condition includes a signal indicating that an incorrect mode of operation of the adaptive cruise control has been detected.

17. (New) The method according to claim 9, wherein the request for taking control includes at least one of a warning activated over a minimum time, an elapsed minimum time between two warnings, a warning maintained until a minimum distance from a preceding vehicle is achieved, a warning maintained until a distance from the preceding vehicle is increasing, and a warning maintained until the driver intervenes by operating one of a gas pedal, a brake pedal and an on/off switch.

18. (New) The method according to claim 9, wherein the criteria includes at least one factor, the at least one factor one of predefined and variably calculated, the at least one factor converting a driver-selected driving program into an operating behavior of the ACC control automatic action.

19. (New) A device for notifying a driver of a vehicle having adaptive cruise control, to inform the driver of an activation of a request for taking control, the request for taking control signaling that one of a maximum braking force and a maximum braking pressure controllable by the adaptive cruise control is being applied and that a deceleration resulting therefrom is not sufficient to automatically decelerate the vehicle in time and to a sufficient degree, comprising:

an arrangement configured to activate the request for taking control when at least two criteria relating to deceleration values are simultaneously satisfied.--.

REMARKS

This Preliminary Amendment cancels, without prejudice, claims 1 to 8 in the underlying PCT Application No. PCT/DE01/00552 and adds new claims 9 to 19. The new claims, inter alia, conform the claims to U.S. Patent and Trademark Office rules and do not add new matter to the application.

In accordance with 37 C.F.R. § 1.121(b)(3), the Substitute Specification (including the Abstract, but without the claims) contains no new matter. The amendments reflected in the Substitute Specification (including Abstract) are to conform the Specification and Abstract to U.S. Patent and Trademark Office rules or to correct informalities. As required by 37 C.F.R. §§ 1.121(b)(3)(iii) and 1.125(b)(2), a Marked Up Version of the Substitute Specification comparing the Specification of record and the Substitute Specification also accompanies this Preliminary Amendment. Approval and entry of the Substitute Specification (including Abstract) is respectfully requested.

The underlying PCT Application No. PCT/DE01/00552 includes an International Search Report, dated June 15, 2001, a copy of which is included. The Search Report includes a list of documents that were considered in the underlying PCT application.

It is respectfully submitted that the subject matter of the present application is new, non-obvious, and useful. Prompt consideration and allowance of the application are respectfully requested.

Respectfully submitted,

By: [signature] Reg. No. 35,952

Dated: 11/28/01

By: [signature]

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[10191/2043]

METHOD AND DEVICE FOR TRIGGERING A REQUEST FOR TAKING CONTROL IN ACC-CONTROLLED VEHICLES

FIELD OF THE INVENTION

The present invention relates to a method and a device for triggering a request for taking control (RTC) in vehicles having adaptive cruise control.

BACKGROUND INFORMATION

Methods and devices for regulating speed and/or acceleration are conventional under the term "tempomat". Supplementing such a device with a sensor, which can recognize preceding vehicles and/or obstacles located in the direction of travel, is also known. These devices may utilize, in the control of vehicle speed, not only their own internal traffic variables, but also traffic variables of the surroundings. Such devices are denoted as adaptive or dynamic vehicle speed controllers or adaptive cruise control (ACC). Such an adaptive travel regulating system may be a convenient assistance to a driver. Therefore, the acceleration and deceleration dynamics, with which the control system activates the forward propulsion and the brakes of the vehicle, may be limited. Furthermore, the adaptive vehicle speed regulator neither should nor can relieve the driver of any responsibility. Instead, the regulator may only relieve the driver of monotonous and tiring activities. Therefore, existing ACC systems may be deliberately made incapable of independently initiating either sharp or full braking, even though the sensory system may be capable of recognizing dangerous situations. In these dangerous situations, existing ACC systems provide a so-called request for taking control, which is activated when the maximum deceleration provided by the automatic system may be no longer sufficient to avoid a collision. The request for

taking control signals the driver acoustically, optically, haptically or kinesthetically that manual intervention using the brake pedal may become necessary. In supplementary fashion, the driver has priority over the vehicle control system at all times, in that he may operate the gas or brake pedal and override or deactivate the system, thereby putting the automatic drive control out of commission.

A fundamental description of such a device is referred to in the paper "Adaptive Cruise Control - System Aspects and Development Trends," given by Winner, Witte et al., at SAE 96, February 26 to 29, 1996 in Detroit (SAE Paper No. 961010). The paper discusses the dynamic restriction of the system for the purpose of riding comfort.

The request for taking control is mentioned in this article as possibly being an acoustic signal which is activated when no sufficient deceleration can be made available so as to react fittingly to the instantaneous situation.

One method and device for travel regulation are described in German Published Patent Application No. 195 44 923. The system includes a radar system and a vehicle speed sensor, from the measured values of which, an acceleration requirement signal is formed. This signal is then used to activate the throttle and the brakes (EGAS system). A limiter assures that the acceleration requirement signal does not exceed the range between a predefined maximum or minimum value, in order to guarantee a designated travel comfort to vehicle passengers. In this system, the driver is notified by a blinking light, a tone generator, a haptic device or a combination of these possibilities. These signal elements are activated when the current deceleration requirement of the vehicle exceeds or approximately reaches the maximum permissible deceleration for the vehicle, and the vehicle is subject to travel control at the same time.

European Published Patent No. 0 348 691 describes concepts for haptic signaling. However, no method is described which points to a reference for triggering a request for taking control.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide criteria with the aid of which the activation of a request for taking control may be triggered, so that the frequency of false alarms may be reduced to a minimum.

This object may be achieved by simultaneously satisfying at least two criteria with respect to deceleration values for activating the request for taking control. In one example embodiment, the two criteria include inequalities with regard to the deceleration values aSoll and aWarn, which must be fulfilled simultaneously before the request for taking control is activated. In this connection, the two deceleration-related variables lead to as complete as possible a reduction in false alarms. Furthermore, the decision thresholds "aMaxDecel + Offset1" 221 and "aMaxDecel + Offset2" 231 of these criteria are not provided as constant threshold values. Instead, they are changed dynamically as a function of instantaneous values, such as vehicle speed.

The acceleration requirement may be used for the activation of actuators, for the setting of a throttle and/or for brake operation. In the present case, the acceleration requirement is denoted as aWarn. If aWarn undershoots a negative acceleration value which corresponds to the brake energizing hysteresis, the vehicle may be decelerated using a braking force in accordance with the absolute value of aWarn. If short term error measurements appear, the system may trigger a request for taking control, even though the situation would not require it. In this manner, false alarms may be created, which may irritate the driver and make the system appear unsophisticated.

To solve this problem, a second acceleration value is introduced, which is subsequently denoted as aSoll. This value aSoll, in addition to aWarn, must undershoot a certain negative acceleration threshold, denoted as "aMaxDecel + Offset2" 231, before the request for taking control can be triggered. The value aSoll may be passed to the brake control or, in the case of propulsion, to the engine control, where it may be used to recalculate a desired engine torque. In order to impart comfort to the vehicle passengers, the value aSoll, which acts directly on the power train and the deceleration elements, may be restricted in several ways. For instance, the maximum admissible acceleration value may be limited by a positive and/or a negative limiting value, so as to impart a comfortable riding sensation. Furthermore, the change over time of the acceleration value may be bounded by limiter 103, in order to prevent a "jolt" in response to a load alteration. Or, the two switching thresholds "aMaxDecel + Offset1" 221 and "aMaxDecel + Offset2" 231 for the input values aWarn and aSoll respectively, may be changed during vehicle operation in accordance with the instantaneous driving situation. For example, the value aMaxDecel may be formed as a function of the instantaneous driving speed, and the starting point of the deceleration can be selected differently for different speeds.

These innovations, according to an example embodiment of the present invention, may avoid false alarms of the ACC request for taking control. If the system recognizes an object in the travel-path area of the vehicle, even for a very short duration (e.g., through disturbances in the side lane or error measurements), the request for taking control is no longer triggered immediately, but rather braking is begun. If the object disappears before the instantaneous deceleration aSoll corresponds to about the maximum deceleration "aMaxDecel + Offset2" 231 available to the system, braking is discontinued without jolting, and the vehicle continues under normal operation. However, if the detected object does not disappear, and the instantaneous deceleration approaches or

reaches the maximum deceleration "aMaxDecel + Offset2" available to the system, the request for taking control 109 may be triggered, if the system predicts that it can no longer decelerate the vehicle in time or in sufficient measure. Further, since braking action may be different at high speeds as compared to low speeds, the system may control the automatic braking action of the ACC system in accordance with the instantaneous speed, in order to generate a braking action which corresponds to that of a responsible driver. This may yield a comfortable and pleasant traveling experience, in view of the time gradient limitation of the value aSoll.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a block diagram of an example embodiment according to the present invention.

Figure 2 illustrates an example functional sequence scenario which may occur during operation of a vehicle under ACC, the sequence scenario being made up of four partial diagrams, each of which plots one variable of the ACC system versus time.

DETAILED DESCRIPTION

Figure 1 is a block diagram of an ACC system that represents how the decision to trigger the request for taking control is formed. The distance dZO between one's own and a preceding vehicle, the relative speed of the target object vRelZO in relation to the preceding vehicle, and the acceleration of the target object aZO enter as input variables into function block 101, in which the value aWarn is formed. The formation of the value aWarn may be accomplished by calculation of a mathematical formula or by storing a characteristics map or table in block 101. In the case of mathematical formula, aWarn may be calculated from

$$aWarn = ((\mathrm{sign}(vRelZO)(vRelZO)^2)/(2dWarn))+aZO \qquad (1)$$

where, in turn, the warning distance dWarn (the relative deceleration path) is calculated from

$$dWarn = (fWarn\ dZO) - Offset3 \qquad (2)$$

fWarn is a factor which may be either definitely predefined as a parameter or variably calculated, for example, in accordance with a set time gap. Using this factor fWarn, for example, the time gap set by the driver or a travel program (comfortable, safe, economical, sporty, ...) predefined by the driver may be taken into consideration.

The value of aWarn thus calculated is then passed on to function block 105.

In function block 102, in a manner similar to block 101, using the input variables distance dZ0, the relative speed of the target object vRelZO and the acceleration of the target object aZO, the value aSoll is formed. As in block 101, the formation of aSoll may be accomplished by mathematical formula or by storing characteristics maps or tables. The value aSoll thus formed is then routed to a limiter which limits the value with respect to minimum or maximum values and a time-related acceleration change. The limited value is then routed to decision block 106 as the value aSollStar. At the same time, aSollStar is passed on to the throttle control and the brake control, which are referred to in Figure 1 as "EGAS System", where they are used in propulsion and braking systems. In function block 104 the maximum deceleration controllable by the ACC system, aMaxDecel, is formed and forwarded to decision blocks 105 and 106. The maximum deceleration controllable by the adaptive driving speed regulating system, "aMaxDecel + Offset2", is changed in blocks 105 and 106 as a function of the instantaneous driving speed, so that the system provides, at all times, a dynamics region that is as great as possible but nevertheless comfortable.

In block 105 an inequality is monitored. Block 105 determines whether the condition

$$aWarn < aMaxDecel + Offset1 \quad (3)$$

is fulfilled. If so, a signal is sent to AND element 107 that the condition examined in block 105 is fulfilled. Similarly, decision block 106 determines whether the condition

$$aSollStar < aMaxDecel + Offset2 \quad (4)$$

is fulfilled, using input values aSollStar and aMaxDecel. If inequality (4) is fulfilled, decision block 106 signals to AND element 107 that the trigger condition is fulfilled.

The offset values Offset1 and Offset2 are parameters that allow the warning thresholds of equations (3) and (4) to be further varied and optimized.

The AND element 107 monitors whether all inputs report simultaneously that the conditions of decision blocks 105 and 106 are fulfilled.

If so, AND element 107 signals the OR element 108 that the conditions for triggering the request for taking control are fulfilled. The OR element 108 signals the request for taking control block 109 that the latter is to be triggered and that the driver is thereby notified that the comfortable braking of the system is not sufficient for obtaining enough deceleration.

Function block 110, which is connected to one of the inputs of AND element 107, and function block 111, which is connected to an input of OR element 108, allow additional criteria to be considered with regard to activating the request for taking control.

The output of function block 110 is connected to the input of AND element 107. Block 110 may monitor the active operational state. For example, block 110 may monitor the operational state of the ACC control and report it to block 107. Further, block 110 may include a function of speed as an AND condition, which may permit activation of the request for taking control only when the vehicle fulfills certain speed requirements. This may allow the activation of the taking-control signal only when the ACC control and regulating device may actively control the gas and the brakes.

In the same manner, a self-diagnosing function may be used to determine whether the ACC control and regulating device is functioning properly. In case the device does not work without error, an output signal is generated in function block 111, which OR element 108 receives, thereby causing the activation of the request for taking control. This arrangement guarantees that the driver is requested to take control in the case of operational failure, and that the ACC control and regulating device can switch itself off safely following the activation of the brake pedal. Furthermore, the sensor function may be checked to ensure that it is properly functioning. Further, the system may process a blindness recognition signal, a rain recognition signal, or a signal which brings about a warning of standing objects in one's own lane, during limited vision conditions, such as fog.

Figure 2 illustrates an example functional sequence scenario which may occur during operation of a vehicle under ACC. The example scenario includes four diagrams, each of which plots one characteristic variable against time. In diagram 210, the distance to target object dZO is plotted against time. In diagram 220, the warning acceleration aWarn is plotted against time. The drawn-in borderline 221 denotes a threshold value "aMaxDecel + Offset1". When this threshold is exceeded, a corresponding signal is passed on to AND element 107 in Figure 1.

In diagram 230, the restricted desired acceleration aSollStar is plotted against time. The variable aSollStar is the variable which is also passed to the control for the electronically controlled throttle(EGAS)or the electronically controlled brake. The drawn-in value 231 represents the threshold value "aMaxDecel+Offset2", at the undershooting of which a corresponding signal is also passed on to AND element 107. In diagram 240, the request for taking control is represented as a digital signal. Here the transition from "0" to "1" indicates the activation of a signal for the request for taking control. The pulse duration of the RTC(t) signal is a function of the duration of the taking-control signal. When the signaling is ended, the RTC(t) curve transitions from "1" to "0".

The four diagrams 210, 220, 230 and 240 are arranged in such a way that their respective time lines run parallel. Thus, the vertical dotted lines of Figure 2 each intersect the four time lines at the same point in time, each intersected point in time being labeled with Latin letters (a to f) at the bottom of Figure 2.

At point in time t=0 in dZO-t diagram 210, a certain constant distance dZO(t=0) separates the ACC-controlled vehicle and the preceding vehicle.

At point in time t=a an additional object of reflection suddenly appears at a very short distance from the ACC-controlled vehicle, is detected for only a very short time, and then disappears suddenly. In this case, the system tries to make available a strong deceleration which is far below warning threshold 221 of the aWarn-t diagram 220. As a result, block 105 in Figure 1 passes a corresponding signal to AND element 107. Signal aSollStar, which also controls the propulsion and brake elements, is created essentially in the same way as aWarn, the only difference being that aSollStar is limited as to a maximum value as well as a gradient. Thus

jumps, steep transitions and values great in amount are excluded from the calculation of aSollStar. Until the desired end values for aSollStar are adjusted, a certain time lapses. Thus, aSollStar may be denoted as being inert or delaying compared to aWarn. In the aSollStar-t diagram 230 the gradient for the curve tangents in each case is a gradient triangle. Thus the gradient of gradient triangles 232 is equal in amount to the maximum possible gradient, since at time point t=a, at least the maximum deceleration controllable by the ACC is required. The deceleration requirement at point t=a lasts only a very short time, so that the curve in aSollStar-t diagram 230 does not reach triggering threshold 231. Thus, no triggering signal is sent by block 106 to AND element 107 and, thus, the RTC-t curve in 240 remains at "0." As a result, the request for taking control is not activated.

Between the two time points t=b and t=c, the preceding vehicle applies its brakes gently. Point t=b is the starting point in time of this gentle brake maneuver and point t=c is the end point in time of this brake maneuver. The distance dZO in diagram 210 decreases during this time, until the brake maneuver is ended at point in time t=c. The deceleration values aWarn in diagram 220 are so small in amount between t=b and t=c that triggering threshold 221 is not reached, since braking is so slight that the brake dynamics region of the ACC system is sufficient for a corresponding deceleration. In the aSollStar-t diagram 230 this becomes noticeable in that the curve takes a flatter course, and the tangent having gradient triangle 233 is also flatter than in the situation at point t=a. Since the ACC system is able to make available sufficient deceleration from t=b to t=c, in the case of this gentle braking, the curve in the RTC-t diagram 240 remains at "0", and, therefore, a request for taking control is not activated.

Between time points t=c and t=d, the preceding vehicle accelerates, which becomes noticeable by the increase in distance dZO and the decrease of the deceleration.

At point t=d, the preceding vehicle decelerates again, but very strongly this time. The value of aWarn immediately darts downwards and crosses the triggering threshold 221 of aWarn. The value of aSollStar drops off at the maximum steepness 232 possible, and reaches triggering threshold "aMaxDecel + Offset2" 231 at point in time t=e.

As of point in time t=e, both triggering criteria are simultaneously fulfilled, and triggering the request for taking control takes place as described in Figure 1, by the AND element 107 and the OR element 108. Activation of the request is represented in the RTC-t diagram 240 by the transition from "0" to "1" at point t=e. At this point in time, the driver is informed that the deceleration of the ACC system is not sufficient to prevent a collision.

At time point t=f the driver steps on the brake pedal in order to achieve a greater deceleration than may be made available by the ACC system. As the driver intervenes by braking at point t=f, the ACC system is simultaneously deactivated.

Triggering thresholds 221 and 231 are not constant values, but rather are variable thresholds, which may be made functions of parameters such as speed. However, curves "aWarn(t)" 220 and aSoll(t)" 230 are normalized in each case with respect to thresholds 221 and 231, for the purpose of making Figure 2 more understandable. The normalization causes the variable thresholds themselves to appear as constant values on the diagrams of Figure 2 (i.e., as horizontals in the diagram).

The calculation of aWarn may take into consideration not only the necessity of reducing the present relative speed within the distance available dWarn, but also the absolute deceleration of the target object which has to be additionally produced to avoid a collision. The value dWarn may further be modified by a factor fWarn, to take into account the time gap or a driving program predefined by the driver.

If the request for taking control is triggered at time point t=e, the system may either alarm the driver for a fixed, definite time period, or it may alarm the driver until the triggering criteria are no longer fulfilled. Necessarily, the request has to be activated for a minimum time, since even during a very short alarm period, the alarm must be noticeable to the driver and clearly understandable. Further, the system may also require a minimum time period to elapse between two requests for taking control, so as not to overload the driver with ACC alarms.

Beside changing the request for taking control by time conditions, one may also do it as a function of distance conditions. For example, a request for taking control that is once activated may remain until a minimum distance from the target object has been achieved or until the distance from the target object increases.

In the RTC-t diagram illustrated in Figure 2, the deactivation of the request for taking control in the form of a negative transition from "1" to "0" is not shown, since this would have a different profile depending on time duration and resetting conditions.

By the use of the measures described in one of the mentioned example embodiments, the probability of a false activation of the ACC request for taking control may be drastically reduced. The motor vehicle driver may, thereby, have more trust in the request for taking control than in conventional systems, and the request for taking control will be received more meaningfully at the same time.

ABSTRACT

In a method and a device for triggering a request for taking control (RTC), a driver of a vehicle having adaptive cruise control is signaled that the adaptive cruise control system may not be capable of controlling a driving situation, and that the driver may have to intervene, the signaling of the driver being generated in accordance with at least two vehicle variables, whereby the probability of a false alarm by the system is reduced, and the triggering of the RTC is adapted to the instantaneous vehicle speed.

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[10191/2043]

METHOD AND DEVICE FOR TRIGGERING A REQUEST FOR TAKING CONTROL IN ACC-CONTROLLED VEHICLES

[Background Information]

FIELD OF THE INVENTION

The present invention [starts from] relates to a method [as well as] and a device [according to the definition of the species of the two independent claims] for triggering a request for taking control (RTC) in vehicles having adaptive cruise control.

BACKGROUND INFORMATION

Methods and devices for regulating speed and/or acceleration [have been known for a long time] are conventional under the term "tempomat". Supplementing such a device with a sensor, which can recognize preceding vehicles [and possibly] and/or obstacles located in the direction of travel, is also known. [The device can thereby include] These devices may utilize, in the control of vehicle speed, not only [its] their own[, i.e.] internal traffic variables, but also traffic variables [in] of the surroundings. Such devices are denoted as adaptive or dynamic vehicle speed controllers[, in English as] or adaptive cruise control (ACC). Such an adaptive travel regulating system [is intended to] may be a convenient assistance to [the] a driver[, and therefore]. Therefore, the acceleration and deceleration dynamics, with which the control system activates the forward propulsion and the brakes of the vehicle, [are] may be limited. Furthermore, [an] the adaptive vehicle speed regulator neither should nor can relieve the driver of any responsibility[, but rather relieve him only]. Instead, the regulator may only relieve the driver of monotonous and tiring activities. Therefore, existing ACC

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systems [are] may be deliberately [not] made [capable] incapable of independently initiating either sharp [braking nor indeed] or full braking, [although] even though the sensory system [is able to recognize] may be capable of recognizing dangerous situations. In these dangerous situations, [all] existing ACC systems provide a so-called request for taking control, which is activated when the maximum deceleration provided by the automatic system [is] may be no longer sufficient to avoid a collision. The request for taking control signals the driver acoustically, optically, haptically or kinesthetically that manual intervention using the brake pedal [is becoming] may become necessary[, since the system in its given design will no longer be able to master the situation before long]. In supplementary fashion, the driver has priority over the vehicle control system at [any time] all times, in that he [can] may operate the gas or brake pedal and override or deactivate the system, [and] thereby [put] putting the automatic drive control out of commission.

A fundamental description of such a device [was contained, for example,] is referred to in the paper "Adaptive Cruise Control - System Aspects and Development Trends," given by Winner, Witte et al., at SAE 96, February 26 to 29, 1996 in Detroit (SAE Paper No. 961010). [Here] The paper discusses the dynamic restriction of the system for the purpose of riding comfort [was described in detail].

The request for taking control [was] is mentioned in this article as possibly being an acoustic signal which is activated when no sufficient deceleration can be made available so as to react fittingly to the instantaneous situation.

One method and device for travel regulation are [known from DE 195 44 923 A1. Among other things, this system has] described in German Published Patent Application No. 195 44 923. The

system includes a radar system and a vehicle speed sensor, from [whose] the measured values of which, an acceleration requirement signal is formed[, which]. This signal is then used to activate the throttle and the brakes (EGAS system). A limiter assures that the acceleration requirement signal does not exceed the range between a predefined maximum or minimum value, in order to guarantee a designated travel comfort to [the] vehicle passengers. In this system, the driver is notified [using] by a blinking light, a tone generator, a haptic device or a combination of these possibilities. These signal elements are activated when the current deceleration requirement of the vehicle exceeds or approximately reaches the maximum permissible deceleration for the vehicle, and the vehicle is subject to travel control at the same time.

[In EP] European Published Patent No. 0 348 691 [B1,] describes concepts for haptic signaling [are pointed out, however]. However, no method is described which points to a reference [to] for triggering a request for taking control.

[Description of the Present Invention, Object, Solution and Advantages]

SUMMARY OF THE INVENTION

[It is accordingly the] It is an object of the present invention to [develop] provide criteria with the aid of which the activation of a request for taking control [can] may be triggered, so that the frequency of false alarms [can] may be reduced to a [possible] minimum.

This object may be achieved by simultaneously satisfying [is achieved by the features of the main claims.

According to the present invention, this happens by] at least two criteria with respect to deceleration values [having to be simultaneously fulfilled] for activating the request for taking control. In [the later exemplary] one example

embodiment, [these are] the two criteria include inequalities with regard to the deceleration values aSoll and aWarn, which [have to] must be fulfilled simultaneously before the request for taking control is activated. In this connection, the two deceleration-related variables [are of such a nature that they] lead to as complete as possible a reduction in false alarms. Furthermore, the decision thresholds "aMaxDecel + Offset1" 221 [as well as] and "aMaxDecel + Offset2" 231 of these criteria are not [given,] provided as [they were up to the present, by] constant threshold values[, but]. Instead, they are changed dynamically[,] as a function of instantaneous values, such as vehicle speed.

[Corresponding to the situation in known systems,] The acceleration requirement may be used for the activation of [the] actuators, for the setting of [the] a throttle [and] and/or for brake operation[, only]. In the [size of] present case, the acceleration requirement [is used: in the present case this] is denoted as aWarn. If [this variable] aWarn undershoots [the] a negative acceleration value which corresponds to the brake energizing hysteresis, the vehicle [is] may be decelerated[, the] using a braking force [depending on] in accordance with the absolute value of aWarn. [Now, if] If short term error measurements appear, the system [will perhaps] may trigger a request for taking control, even though the situation would not require it. In this manner, false alarms [are] may be created, which [can] may irritate the driver and make the system appear unsophisticated.

[For the solution of] To solve this problem, a second acceleration value is introduced, which is subsequently denoted as aSoll. This value aSoll, [just as] in addition to aWarn, must undershoot a certain negative acceleration threshold, denoted as "aMaxDecel + Offset2" 231 [in the exemplary embodiment, so that both criteria together trigger], before the request for taking control[. In this connection,

aSoll is the value which is] can be triggered. The value aSoll may be passed [on] to the brake control[,] or, in the case of propulsion, [is passed on] to the engine control, [and is there recalculated as the] where it may be used to recalculate a desired engine torque. In order to impart comfort to the vehicle passengers, the value aSoll, which acts directly on the power train and the deceleration elements, [is] may be restricted in several ways. [Thus] For instance, the maximum admissible acceleration value [is] may be limited by a positive [and also by] and/or a negative limiting value, so as to impart a comfortable riding sensation. Furthermore, the change over time of the acceleration value [is] may be bounded [in the] by limiter 103, in order to prevent [thereby the so-called] a "jolt" in response to a load alteration. [The] Or, the two switching thresholds "aMaxDecel + Offset1" 221 and "aMaxDecel + Offset2" 231 for the input values aWarn and aSoll[, in response to whose undershooting the request for taking control 109 is triggered, can be changed during the operation, according to the present invention, so that the switching threshold values can be set to] respectively, may be changed during vehicle operation in accordance with the instantaneous driving situation. [In this connection] For example, the value aMaxDecel [is] may be formed as a function of the instantaneous driving speed, [whereby, at different speeds, one can also select] and the starting point of the deceleration can be selected differently for different speeds.

These innovations, according to an example embodiment of the present invention, may avoid false alarms of the ACC request for taking control. If the system recognizes an object in the travel-path area of the vehicle, even for a very short duration[, for example] (e.g., through disturbances in the side lane or error measurements[, by using the measures of the present invention]), the request for taking control is no longer triggered immediately, but rather braking is begun. If [this] the object disappears [again] before the instantaneous

deceleration aSoll corresponds to about the maximum deceleration "aMaxDecel + Offset2" 231 available to the system, braking is discontinued [again] without jolting, and the vehicle continues under normal operation. However, if the detected object does not disappear, and the instantaneous deceleration approaches or reaches the maximum deceleration "aMaxDecel + Offset2" available to the system, [or reaches it,] the request for taking control 109 [is] may be triggered, if the system [still] predicts that it can no longer decelerate the vehicle in time or in sufficient measure. [Experience has also shown that braking action, as a rule, turns out very differently in the case of high speeds and in the case of low speeds. That is why the present invention also made the] Further, since braking action may be different at high speeds as compared to low speeds, the system may control the automatic braking action of the ACC system [a function of] in accordance with the instantaneous speed, in order [thus] to generate a braking action which corresponds to that of a responsible driver. This [further yields the impression of] may yield a comfortable and pleasant [travel, also] traveling experience, in view of the time gradient limitation of the value aSoll.

[Description of the Drawings and the Exemplary Embodiment]

BRIEF DESCRIPTION OF THE DRAWINGS

[In the following, an exemplary embodiment of the present invention, as well as a possible functional sequence scenario, which can occur during ACC operation, are explained with the aid of two drawings.

Figure 1 shows] Figure 1 is a block diagram of an [exemplary] example embodiment according to the present invention.

Figure 2 [shows a possible] illustrates an example functional sequence scenario which [can] may occur during operation of [the] a vehicle under ACC, the sequence scenario being made up

of four partial diagrams [in]<u>,</u> each of which <u>plots</u> one variable of the ACC system [is plotted against time.] <u>versus time.</u>

[Figure 1 shows an ACC system in a block diagram, in extract. What is shown in detail is]

<u>DETAILED DESCRIPTION</u>

<u>Figure 1 is a block diagram of an ACC system that represents</u> how the decision to trigger the request for taking control is formed. The distance dZO between one's own and [the] <u>a</u> preceding vehicle, the relative speed of the target object vRelZO in relation to the preceding vehicle, [as well as] <u>and</u> the acceleration of the target object aZO enter as input variables into function block 101, in which the value aWarn is formed. [This] <u>The</u> formation of the value aWarn [can] <u>may</u> be accomplished by calculation [by means] of a mathematical formula or by storing a characteristics map or [a] table in block 101. In the case of [doing the calculation by] mathematical formula, aWarn [is advantageously] <u>may be</u> calculated from

$$aWarn = ((sign(vRelZO)(vRelZO)^2)/(2dWarn))+aZO \qquad (1)$$

where, in turn, the warning distance dWarn (the relative deceleration path) is calculated from

$$dWarn = (fWarn\ dZO) - Offset3 \qquad (2)$$

fWarn is a factor [here,] which [can] <u>may be</u> either [be] definitely predefined as a parameter or variably calculated[; in the latter case it can preferably be]<u>, for example, in accordance with</u> a [function of the] set time gap. Using this factor fWarn, for example, the time gap set by the driver or a travel program (comfortable, safe, economical, sporty,[...)] <u>...)</u> predefined by the driver [can] <u>may</u> be taken into consideration.

The value of aWarn thus calculated is then passed on to function block 105.

In function block 102, in a manner similar to [the one in] block 101, using the input variables distance dZ0, the relative speed of the target object vRelZO [as well as] and the acceleration of the target object aZO, the value aSoll is formed. [This is done again, as] As in block 101, the formation of aSoll may be accomplished by [using a] mathematical formula or by storing characteristics maps or tables. The value aSoll thus formed is then routed to a limiter which limits [this] the value with respect to minimum or maximum values [as well as with respect to the] and a time-related acceleration change[, and routes it]. The limited value is then routed to decision block 106 as the value [aSetpointStar] aSollStar. At the same time, [this value aSetpointStar] aSollStar is passed on to the throttle control and the brake control, which are [marked] referred to in Figure 1 as "EGAS System", where they are [converted to] used in propulsion and braking systems. In function block 104 the maximum deceleration controllable by the ACC system, aMaxDecel, is formed[,] and forwarded to decision blocks 105 and 106. The maximum deceleration controllable by the adaptive driving speed regulating system, "aMaxDecel + Offset2", is changed [there] in blocks 105 and 106 as a function of the instantaneous driving speed, so that the system provides, at all times, a dynamics region that is as great as possible but nevertheless comfortable.

In block 105 an inequality is monitored. [It is examined here] Block 105 determines whether the condition

$$aWarn < aMaxDecel + Offset1 \quad (3)$$

is fulfilled. If [this is the case] so, a signal is sent [in the appropriate manner] to [subsequently connected] AND

element 107 that the condition [that was to be] examined in block 105 is fulfilled. [In the same way] Similarly, decision block 106 [examines] determines whether the condition

$$[\text{aSetpointStar}]\ \text{aSollStar} < \text{aMaxDecel} + \text{Offset2} \quad (4)$$

is fulfilled, [whose variables are composed of the] using input values [aSetpointStar] aSollStar and aMaxDecel. [In case] If inequality (4) is fulfilled, decision block 106 signals[, also in suitable fashion,] to AND element 107 that the trigger condition is fulfilled.

The offset values Offset1 and Offset2 are parameters [whereby] that allow the warning thresholds [according to equation] of equations (3) and [equation](4) [can] to be further varied and optimized.

The AND element 107 monitors whether all inputs report simultaneously that the conditions of [preconnected] decision blocks 105 and 106 are fulfilled.

If [this is the case, then] so, AND element 107 signals the OR element 108 that the conditions for triggering the request for taking control are fulfilled. The OR element 108 signals [to] the request for taking control block 109 that the latter is to be triggered[,] and that the driver is thereby notified that the comfortable braking of the system is not sufficient for obtaining enough deceleration.

[By the use of function] Function block 110, which is connected to one of the inputs of AND element 107, [as well as of] and function block 111, which is connected to an input of OR element 108, allow additional criteria to be considered with regard to activating the request for taking control [can be taken into consideration.].

[Thus, the] The output of function block 110 is connected to the input of AND element 107. [This function 110 can expediently be monitoring] Block 110 may monitor the active operational state. [In this case,] For example, block 110 [would] may monitor the operational state of the ACC control and report [this to block 107 in suitable fashion. It would also be expedient to install] it to block 107. Further, block 110 may include a function of speed as an AND condition, which [would] may permit activation of the request for taking control only when the vehicle fulfills certain speed requirements. This [has] may allow the [result that] activation of the taking-control signal [is indeed activated] only when the ACC control and regulating device [can] may actively control the gas and the brakes.

In the same [way, one can advantageously] manner, a self-diagnosing function may be used to determine whether the ACC control and regulating device is functioning properly[, by using a self-diagnosing function]. In case [this] the device does not work without error, an output signal is generated in function block 111, which OR element 108 receives, [and finally causes] thereby causing the activation of the request for taking control. This arrangement guarantees that the driver is requested to take control in the case of operational failure, and that the ACC control and regulating device can switch itself off safely[,] following the activation of the brake pedal. Furthermore, [it is advantageous to check whether the sensor function is enssured. Thus, it is expedient to] the sensor function may be checked to ensure that it is properly functioning. Further, the system may process a blindness recognition signal [or], a rain recognition signal, or [to process] a signal which brings about a warning of standing objects in one's own lane, during limited vision conditions, such as [in] fog.

Figure 2 illustrates [a scenario for a vehicle operated by an ACC, as can happen at any time in reality. This illustration is made up of 4 diagrams, drawn one below another, in which, in each case] an example functional sequence scenario which may occur during operation of a vehicle under ACC. The example scenario includes four diagrams, each of which plots one characteristic variable [is plotted] against time. In diagram 210, the distance to [the] target object dZO is plotted against time. In diagram 220, the warning acceleration aWarn [was also] is plotted against time. The drawn-in borderline 221 [here] denotes a threshold value "aMaxDecel + Offset1"[, and when it]. When this threshold is exceeded, a corresponding [signaling] signal is passed on to AND element 107 in Figure 1.

In diagram 230, the restricted desired acceleration [aSetpointStar was] aSollStar is plotted against time. [This] The variable aSollStar is the variable which is also [has] passed [on] to [it a] the control for the electronically controlled throttle[(EGAS) or an] (EGAS)or the electronically controlled brake. The drawn-in value 231 [here again] represents the threshold value "aMaxDecel+Offset2", at the undershooting of which a corresponding [signaling] signal is also passed on to AND element 107. In [the bottom] diagram 240, the request for taking control is represented as a digital signal. Here the transition from "0" to "1" [stands for] indicates the activation of a signal for the request for taking control [signal]. The pulse duration of the RTC(t) signal is a function of the duration of the taking-control signal. When the signaling is ended, the RTC(t) curve [jumps back] transitions from "1" to "0".

The [4] four diagrams 210, 220, 230 and 240 are arranged in such a way that [the] their respective time lines run parallel. [One can thereby represent places] Thus, the vertical dotted lines of Figure 2 each intersect the four time

lines at the same point in time [by vertical lines which are entered dotted in Figure 2. Special points in time are lettered as Latin letters a to f at the lower edge], each intersected point in time being labeled with Latin letters (a to f) at the bottom of Figure 2.

At point in time t=0 in dZO-t diagram 210, a certain constant distance dZO(t=0) [prevails between] separates the ACC-controlled vehicle and the preceding vehicle [which is held constant].

At point in time t=a an additional object of reflection suddenly appears [from nowhere, which is] at a very short distance from the ACC-controlled vehicle, is detected for only a very short time, and then disappears [again just as] suddenly. In this case, the system tries to make available a strong deceleration which is far below warning threshold 221 of the aWarn-t diagram 220. [Because of that] As a result, block 105 in Figure 1 passes a corresponding signal [on] to AND element 107. Signal [aSetpointStar] aSollStar, which also controls the propulsion and brake elements, is created essentially in the same way as aWarn, the only difference being that [aSetpointStar] aSollStar is limited as to a maximum value as well as a gradient. Thus jumps, steep transitions [as well as] and values great in amount are excluded [as far as aSetpointStar is concerned] from the calculation of aSollStar. Until the desired end values for [aSetpointStar] aSollStar are adjusted, a certain time lapses[, which is why this signal can]. Thus, aSollStar may be denoted as being inert or delaying compared to aWarn. In the [aSetpointStar] aSollStar-t diagram 230 the gradient for the curve tangents[, is sketched] in each case [as] is a gradient triangle. Thus the gradient of gradient triangles 232 is equal in amount to the maximum possible gradient, since [in the exemplary case] at time point t=a, at least the maximum deceleration controllable by the ACC[, or even more]

is required. The deceleration requirement at point t=a lasts only a very short time, so that the curve in [aSetpointStar] aSollStar-t diagram 230 does not reach triggering threshold 231. Thus, no triggering signal is [given] sent by block 106 to AND element 107 [either, which is why activating the request for taking control does not occur, and]and, thus, the RTC-t curve in 240 remains at "0." As a result, the request for taking control is not activated.

Between the two time points t=b and t=c, the preceding vehicle applies its brakes gently. [It follows that point] Point t=b is the starting point in time of this gentle brake maneuver and [that] point t=c is the end point in time of this brake maneuver. The distance dZO in diagram 210 decreases during this time, until the brake maneuver is [closed] ended at point in time t=c. The deceleration values aWarn in diagram 220 are so small in amount between t=b [to] and t=c that triggering threshold 221 is not reached, [which means logically that] since braking is so slight that the brake dynamics region of the ACC system is sufficient for a corresponding deceleration. In the [aSetpointStar] aSollStar-t diagram 230 this becomes noticeable in that the curve takes a flatter course, and the tangent having gradient triangle 233 is also flatter than in the situation at point t=a. Since the ACC system [was] is able to make available sufficient deceleration [in the case] from t=b to t=c, in the case of this gentle braking [a request for taking control is also not activated], [and so] the curve in the RTC-t diagram 240 [still remains at "0".] remains at "0", and, therefore, a request for taking control is not activated.

[In the following] Between time points t=c and t=d, the preceding vehicle accelerates [again], which becomes noticeable by the increase in distance dZO and the decrease of the deceleration.

At point t=d, the preceding vehicle decelerates again, but [not] very strongly this time. The value of aWarn immediately darts downwards and crosses the triggering threshold 221 of aWarn. The value of [aSetpointStar] aSollStar drops off at the maximum steepness 232 possible, and reaches triggering threshold "aMaxDecel + Offset2" 231 at point in time t=e.

As of [this] point in time t=e, both triggering criteria are simultaneously fulfilled, and triggering the request for taking control takes place as described in Figure 1, by the AND element 107 and the OR element 108. [This is illustrated] Activation of the request is represented in the RTC-t diagram 240 by the [curve jumping] transition from "0" to "1" at point t=e. At this point in time [e], the driver is informed that the deceleration of the ACC system is not sufficient to prevent a collision.

At time point t=f the driver [decides to step] steps on the brake pedal in order to achieve a greater deceleration than [could] may be made available by the ACC system. As the driver intervenes by braking at point t=f, the ACC system is simultaneously deactivated.

Triggering thresholds 221 and 231[, as was mentioned before, are not fixed,] are not constant values, but rather are variable thresholds, [and can] which may be made functions of parameters such as speed. [Curves] However, curves "aWarn(t)" 220 and aSoll(t)" 230 are normalized in each case [on] with respect to thresholds 221 and 231, for the purpose of making [it] Figure 2 more understandable[, so that the]. The normalization causes the variable thresholds themselves [appear as a constant value, that is] to appear as constant values on the diagrams of Figure 2 (i.e., as horizontals in the diagram).

The calculation of aWarn [takes] may take into consideration not only the necessity of reducing the present relative speed within the distance available dWarn, but also the absolute deceleration of the target object which has to be additionally produced to avoid a collision. The value dWarn [can] may further be modified by a factor fWarn, to take into account the time gap or a driving program predefined by the driver.

If the request for taking control is triggered [as] at time point t=e, [it can] the system may either alarm the driver for a fixed, definite time period, or it [can] may alarm the driver until the triggering criteria are no longer fulfilled. [Of necessity] Necessarily, the request has to be activated for a minimum time, since even during a very short alarm period [of], the alarm[, this] must be noticeable to the driver and clearly understandable. [It is also expedient to have] Further, the system may also require a minimum time period to elapse between two requests for taking control, so as not to overload the driver with ACC alarms.

[However, besides] Beside changing the request for taking control by [such] time conditions, one [can] may also do it as a function of distance conditions. [Thus, it is expedient, for] For example, [that] a request for taking control that is once activated [has to] may remain [so] until a minimum distance from the target object has been achieved [again,] or until the distance from the target object [is getting larger again] increases.

In the RTC-t diagram illustrated in Figure 2, the deactivation of the request for taking control in the form of a negative transition from "1" to "0" is not shown, since this would have a different profile depending on time duration and resetting conditions.

By the use of the measures described in one of the mentioned [types of embodiment, it is possible drastically to reduce] example embodiments, the probability of a false activation of the ACC request for taking control may be drastically reduced. The motor vehicle driver [can] may, thereby, have more trust in the request for taking control than [up to now,] in conventional systems, and [in that case] the request for taking control will be received more meaningfully at the same time.

[Abstract]

ABSTRACT

[A] In a method and a [corresponding] device [are proposed] for triggering a request for taking control (RTC), [which signals] a driver of a vehicle having adaptive cruise control is signaled that [the driving situation can probably not be controlled any more by] the adaptive cruise control system may not be capable of controlling a driving situation, and that the driver [has to intervene. By the monitoring of]may have to intervene, the signaling of the driver being generated in accordance with at least two [or a plurality of] vehicle variables [which are causal in triggering the RTC,], whereby the probability of a false alarm by the system is reduced, and the triggering of the RTC is adapted to the instantaneous vehicle speed.

[

Figure 1]